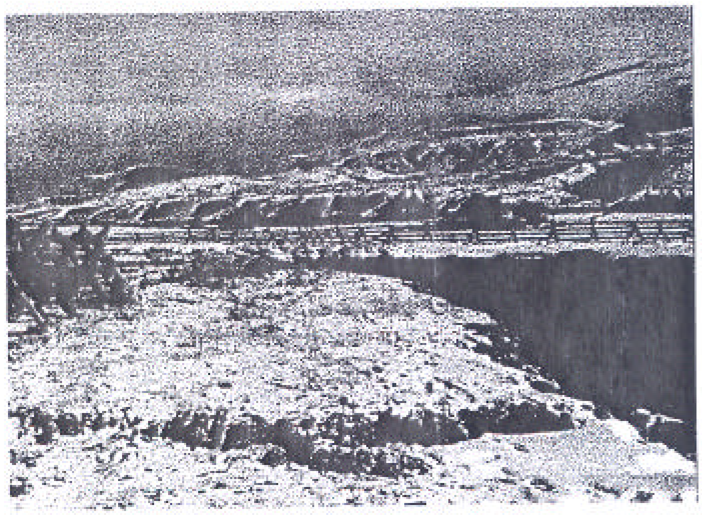
Lemhi River Watershed TMDL



December 1999

An Allocation of Nonpoint Source Pollutants in the Water Quality Limited Watersheds of the Lemhi River Valley

Idaho Department of Health and Welfare

Division of Environmental Quality

1410 North Hilton

Bosie, ID 83706

Appendix A. Sediment TMDL Methods and Results

Introduction

This appendix documents the analytical techniques and data used to develop the gross sediment budget and instream sediment measures used in the TMDLs. It describes the methods, data, and results for the following, 1) streambank erosion inventory; 2) gully erosion and mass wasting inventory; and 3) surface and subsurface fine sediment data collection techniques. These data are intended to first characterize the natural and existing condition of the landscape, second estimate the desired level of erosion and sedimentation, and third provide baseline data which can be used in the future to track the effectiveness of TMDL implementation. For example, the streambank erosion and gully inventories can be repeated and ultimately provide an adaptive management or feedback mechanism.

Streambank Erosion Inventory

The streambank erosion inventory used to estimate background and existing streambank erosion followed methods outlined in the proceedings from the Natural Resource Conservation Service (NRCS) Channel Evaluation Workshop (1983). Using the direct volume method, sub-sections of 1996 §303(d) watersheds were surveyed to determine the extent of chronic bank erosion and estimate the needed reductions.

The NRCS Stream Bank Erosion Inventory is a field based methodology, which measures streambank/channel stability, length of active eroding banks, and bank geometry. The streambank/channel stability inventories were used to estimate the long-term lateral recession rate. The recession rate is determined from field evaluation of streambank characteristics that are assigned a categorical rating ranging from 0 to 3. The categories of rating the factors and rating scores are:

Bank Stability:

- Do not appear to be eroding - 0
- Erosion evident - 1
- Erosion and cracking present - 2
- Slumps and clumps sloughing off - 3

Bank Condition:

- Some bare bank, few rills, no vegetative overhang - 0
- Predominantly bare, some rills, moderate vegetative overhang - 1
- Bare, rills, severe vegetative overhang, exposed roots - 2
- Bare, rills and gullies, severe vegetative overhang, falling trees - 3

Vegetation / Cover On Banks:
Predominantly perennials or rock-covered - 0
Annuals / perennials mixed or about 40% bare - 1
Annuals or about 70% bare - 2
Predominantly bare - 3

Bank / Channel Shape:
V - Shaped channel, sloped banks - 0
Steep V - Shaped channel, near vertical banks - 1
Vertical Banks, U - Shaped channel - 2
U - Shaped channel, undercut banks, meandering channel - 3

Channel Bottom:
Channel in bedrock / noneroding - 0
Soil bottom, gravels or cobbles, minor erosion - 1
Silt bottom, evidence of active downcutting - 2

Deposition:
No evidence of recent deposition - 1
Evidence of recent deposits, silt bars - 0

Cumulative Rating

Slight (0-4) Moderate (5-8) Severe (9+)

From the Cumulative Rating, the lateral recession rate is assigned.

0.01 - 0.05 feet per year	**Slight**
0.06 - 0.15 feet per year	**Moderate**
0.16 - 0.3 feet per year	**Severe**
0.5+ feet per year	**Very Severe**

Streambank stability can also be characterized through the following definition and the corresponding streambank erosion condition rating from Bank Stability or Bank Condition above are included in italics.

Streambanks are considered stable if they do not show indications of any of the following features:

- **Breakdown** - Obvious blocks of bank broken away and lying adjacent to the bank breakage. *Bank Stability Rating 3*
- **Slumping or False Bank** - Bank has obviously slipped down, cracks may or may not be obvious, but the slump feature is obvious. *Bank Stability Rating 2*
- **Fracture** - A crack is visibly obvious on the bank indicating that the block of bank I about to slump or move into the stream. *Bank Stability Rating 2*
- **Vertical and Eroding** - The bank is mostly uncovered and the bank angle is steeper than 80 degrees from the horizontal. *Bank Stability Rating 1*

Streambanks are considered covered if they show any of the following features:

- Perennial vegetation ground cover is greater than 50%. *Vegetation/Cover Rating 0*
- Roots of vegetation cover more than 50% of the bank (deep rooted plants such as willows and sedges provide such root cover). *Vegetation/Cover Rating 1*
- At least 50% of the bank surfaces are protected by rocks of cobble size or larger. *Vegetation/Cover Rating 0*
- At least 50% of the bank surfaces are protected by logs of 4 inch diameter or larger. *Vegetation/Cover Rating 1*

Streambank stability is estimated using a simplified modification of Platts, Megahan, and Minshall (1983, p. 13) as stated in *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams* (Bauer and Burton, 1993). The modification allows for measuring streambank stability in a more objective fashion. The lengths of banks on both sides of the stream throughout the entire linear distance of the representative reach are measured and proportioned into four stability classes as follows:

- **Mostly covered and stable (non-erosional).** Streambanks are Over 50% Covered as defined above. Streambanks are Stable as defined above. Banks associated with gravel bars having perennial vegetation above the scourline are in this category. *Cumulative Rating 0 - 4 (slight erosion) with a corresponding lateral recession rate of 0.01 - 0.05 feet per year.*
- **Mostly covered and unstable (vulnerable).** Streambanks are Over 50% Covered as defined above. Streambanks are Unstable as defined above. Such banks are typical of ? false banks" observed in meadows where breakdown, slumping, and/or fracture show instability yet vegetative cover is abundant. *Cumulative Rating 5 - 8 (moderate erosion) with a corresponding lateral recession rate of 0.06 - 0.2 feet per year.*
- **Mostly uncovered and stable (vulnerable).** Streambanks are less than 50% Covered as defined above. Streambanks are Stable as defined above. Uncovered, stable banks are typical of streambanks trampled by concentrations of cattle. Such trampling flattens the bank so that slumping and breakdown do not occur even though vegetative cover is significantly reduced or eliminated. *Cumulative Rating 5 - 8 (moderate erosion) with a corresponding lateral recession rate of 0.06 - 0.2 feet per year.*
- **Mostly uncovered and unstable (erosional).** Streambanks are less than 50% Covered as defined above. They are also Unstable as defined above. These are bare eroding streambanks and include ALL banks mostly uncovered, which are at a steep angle to the water surface. *Cumulative Rating 9+ (severe erosion) with a corresponding lateral recession rate of over 0.5 feet per year.*

Streambanks were inventoried to quantify bank erosion rate and annual average erosion. These data were used to develop a quantitative sediment budget to be used for TMDL development.

Site Selection
The first step in the bank erosion inventory is to identify key problem areas. Streambank erosion tends to increase as a function of watershed area (NRCS, 1983). As a result, the lower stream segment of larger watersheds tend to be problem areas. These stream segments tend to be alluvial streams commonly classified as response reaches (Rosgen B and C channel types).

Because it is often unrealistic to survey every stream segment, sampled reaches were used and bank erosion rates are extrapolated over a larger stream segment. The length of the sampled reach is a function of stream type variability where streams segments with highly variable channel types need a large sample, whereas segments with uniform gradient and consistent geometry need less. Typically between 10 and 30 percent of streambank needs to be inventoried. Often, the location of some stream inventory reaches is more dependent on land ownership than watershed characteristics. For example, private land owners are sometimes unwilling to allow access to stream segments within their property.

Stream reaches are subdivided into *sites* with similar channel and bank characteristics. Breaks between sites are made where channel type and/or dominate bank characteristics change substantially. In a stream with uniform channel geometry there may be only one site per stream reach, whereas in an area with variable conditions there may be several sites. Subdivision of stream reaches is at the discretion of the field crew leader.

Field Methods
Streambank erosion or channel stability inventory field methods were originally developed by the USDA USFS (Pfankuch, 1975). Further development of channel stability inventory methods are outlined in Lohrey (1989) and NRCS (1983). As stated above, the NRCS (1983) document outlines field methods used in this inventory. However, slight modifications to the field methods were made and are documented.

Field crews typically consist of two to four people and are trained as a group to ensure quality control or consistent data collection. Field crews survey selected stream reaches measuring bank length, slope height, bankfull width and depth, and bank content. In most cases, a Global Positioning System (GPS) is used to locate the upper and lower boundaries of inventoried stream reaches. Additionally, while surveying field crews photograph key problem areas.

Bank Erosion Calculations
The direct volume method is used to calculate average annual erosion rates for a given stream segment based on bank recession rate determined in the survey (NRCS, 1983). The erosion rate (tons/mile/year) is used to estimate the total bank erosion of the selected stream corridor. The direct volume method is summarized in the following equations:

$$E = [A_E * R_{LR} * ?_B]/2000 \text{ (lbs/ton)}$$

where:
E = bank erosion over sampled stream reach (tons/yr/sample reach)
A_E = eroding area (ft^2)
R_{LR} = lateral recession rate (ft/yr)
$?_B$ = bulk density of bank material (lps/ft^3)

The bank erosion rate (E_R) is calculated by dividing the sampled bank erosion (E) by the total stream length sampled:

$$E_R = E/L_{BB}$$

where:
E_R = bank erosion rate (tons/mile/year)
E = bank erosion over sampled stream reach (tons/yr/sample reach)
L_{BB} = bank to bank stream length over sampled reach

Total bank erosion is expressed as an annual average. However, the frequency and magnitude of bank erosion events are greatly a function of soil moisture and stream discharge (Leopold et al, 1964). Because channel erosion events typically result from above average flow events, the annual average bank erosion value should be considered a long term average. For example, a 50 year flood event might cause five feet of bank erosion in one year and over a ten year period this events accounts for the majority of bank erosion. These factors have less of an influence where bank trampling is the major cause of channel instability.

The *eroding area* (A_E) is the product of linear horizontal bank distance and average bank slope height. Bank length and slope heights are measured while walking along the stream channel. Pacing is used to measure horizontal distance, and bank slope heights are continually measured and averaged over a given reach or site. The horizontal length is the length of the right or left bank, not both. Typically, one bank along the stream channel is actively eroding. For example, the bank on the outside of a meander. However, both banks of channels with severe headcuts or gullies will be eroding and are to be measured separately and eventually summed.

Determining the *lateral recession rate* (R_{LR}) is one of the most critical factors in this methodology (NRCS, 1983). Several techniques are available to quantify bank erosion rates: for example, aerial photo interpretation, anectodal data, bank pins, and channel cross-sections.

To facilitate consistent data collection, the NRCS developed rating factors used to estimate lateral recession rate. Similar to methods developed by Pfankuch (1975), the NRCS method measures bank and channel stability, and then uses the ratings as surrogates for bank erosion rates. For the Lemhi River, anectodal data were used to estimate bank recession rates. Table 1 summarizes the results and recession rates are in

Table 1. Bank lateral recession rates measured in Lemhi River Subbasin using anecdotal data.

Site	Lateral Recession (ft)	Time (yr)	Recession Rate (ft/yr)	Comments
18 - mile Creek (silt-clay)	2.5	2	1.25	Bank erosion results from cattle trampling bank rather
				than stream discharge. Likely not a good measure for other streams.
Kitley Creek (clay-silt)	14	37	0.38	Fence posts exposed, Fence built in late 1950s.
				Assume 1960 for rate calculation. Two feet lost in 1997 flood event.
Geertson Creek (silt-sand)	15	52	0.29	Cedar fence built in 1945.

general agreement with the NRCS (1983) categories. Additionally, Table 2 is included to compare estimated recession rates to rates measured in recent research projects.

The *bulk density* (?$_{B}$) of bank material is measured ocularly in the field. Soil bulk density is the weight of material divided by its volume, including the volume of its pore spaces. A table of typical soil bulk densities can be used, or soil samples can be collected and soil bulk density measured in the laboratory.

Table 2. Bank lateral recession rate measured in various research projects.

Reference	Average Migration Rate (ft/yr)		Comments
From Burckhardt and Todd (1998)	forested	unforested	Data collected in North Central Missouri in glacial deposits.
	0.7	5.3	Included here to show extreme values in highly
	1.9	5.6	unstable sand-gravel bank material.
	1.4	3.1	
	2.3	7	
	0.3	1.7	
	0.9	5.6	
	2.3	10.5	
	4.5	8.6	
	0.6	0.9	
From Trimble (1997)	0.65		Urbanized watershed. Sand-silt bank material
	13		

Gully Erosion and Mass Wasting

Two methods were used to estimate the natural and anthropogenic frequency of gully erosion and mass wasting. First, field inventories were conducted to quantify the present level of gully formation and mass wasting occurrence. Second, historic aerial photos were used to document the spatial and temporal characteristics of gully formation and mass wasting.

The gully erosion field inventory followed methods outlined in the proceedings from the Natural Resource Conservation Service (NRCS) Channel Evaluation Workshop (1983). Much like the streambank erosion inventory technique, the direct volume method is used to quantify the amount and rate of sediment erosion and delivery from gullies.

The mass wasting inventory was conducted using similar techniques, however, because these features tend to be discrete sources of sediment the average annual sediment input was not quantified. Rather, the total volume and mass delivered to the stream channel were estimated.

Active features were surveyed using standard surveying equipment. The geometry of each feature was surveyed and sediment samples were collected. The sediment samples were sieved and weighed to quantify the cumulative grain size distribution of the sediment sources. These data are reported in Plate 9.

The aerial photos were interpreted using standard techniques described by Compton (1996). Resource aerial photos, taken by the BLM, from 1946, 1960, 1974, 1992, and 1993 were used to characterize the location of features and to quantify the approximate time of gully and mass wasting initiation. The photos were also used to characterize changes in land use, riparian cover, and bank condition where possible.

Subsurface Fine Sediment Sampling

McNeil Sediment Core samples were collected to describe size composition of bottom materials in salmonid spawning beds of streams on the 303(d) list for sediment. Research has shown that subsurface fine sediment composition is important to egg and fry survival, Hall (1986), Reiser and White (1988). Data gathered as part of the TMDL and other studies relevant to the Lemhi River Subbasin are presented in Plate 10.

Site Selection

Sample sites selected displayed characteristics of gravel size, depth and velocity required by salmonids to spawn and were determined to be adequate spawning substrate by an experienced fisheries biologist. Samples were collected during periods of low discharge, as described in McNeil and Ahnell (1964) to minimize loss of silt in suspension within the core sampling tube. Sample sites were generally in the lower reach of streams where spawning habitat was determined to exist.

Field Methods

A 12 inch stainless steel open cylinder is worked manually as far as possible, at least 4 inches, into spawning substrate without allowing flowing water to top the core sampling tube. Samples of bottom materials were removed by hand, using a stainless steel mixing bowl, to a depth of at least 4 inches and placed into buckets. After solids were removed from the core sampling tube and placed into buckets, the remaining suspended material was discarded. It is felt that this fine material would be removed through the physical action of excavating a redd and would not be a significant factor with regard to egg to fry survival. Additionally, rinsing of sieves to process the sample results in some loss of the fraction below the smallest (0.053 mm) mesh size.

Samples were placed wet into a stack of sieves and were separated into 10 size classes by washing and shaking them through nine standard Tyler sieves having the following square mesh openings (in mm): 63, 25, 12.5, 6.3, 4.75, 2.36, .85, .212, .053. Silt passing the finest screen was discarded.

The volume of solids retained by each sieve was measured after the excess water drained off. The contents of each of the sieves were placed in a bucket filled with water to the level of a spigot for measurement by displacement. The water displaced by solids was collected in a plastic bucket and transferred to a 2,000 ml graduated cylinder and measured directly. Water displaced by solids retained by the smaller diameter sieves was also collected in a plastic bucket and measured in a 250 ml graduated cylinder. Variation in sample volumes was caused by variation in porosity and core depth. All sample fractions were expressed as a percentage of the sample with and without the 63 mm fraction.

Three sediment core samples were collected at each sample site and grouped together by fractions 6.3 mm and greater and 4.75mm to 0.53mm. The results for a particular site are the percentage of 4.75mm to 0.53mm as a percent of the total sample. Standard deviation is calculated for estimates including and excluding particles 63 mm and above.

Surface Erosion from Roads

Surface erosion from unimproved/unsurfaced roads and four-wheel drive trails considered to generally be within 50 meters of TMDL waters was estimated using numerical values from an extension of the US Department of Agriculture WEPP model. This model has been widely applied to estimate surface erosion from unsurfaced roads, particularly on USFS lands. The model is based on the gradient of the road, the distance to the stream (buffer distance), the slope angle to the stream (buffer slope), the width of the road, the soil type adjacent to the road and the amount of precipitation on the road. The assumptions used for the estimated tons of sediment produced over a particular reach of road were that the buffer slope was 25%, road width was 15 feet, distance to the stream was 30 feet, the soil or road material was gravelly loam and erosion was primarily snowmelt driven which uses an annual precipitation of 32 inches. It is likely that erosion is consistently over estimated given these assumptions within the Lemhi watershed, however the purpose is to conservatively estimate erosion load and to prioritize sources that may be having an impact on aquatic beneficial uses. It is felt that erosion estimates are a valid tool for identifying and ranking sources in which to apply reductions based on implementation of BMPs.

Segments to be evaluated were identified using 7.5 minute USGS topographical maps and orthoquad aerial photos. The distance to water was estimated using the same maps and photos. Gradient was determined using a Scale Master Plus® digital plan measure to determine road distance for each 40 foot contour interval along the road being evaluated.

Erosion estimates from the WEPP model were made for gradients of 2%, 4%, 8% and 16%. Linear regression was used to interpolate intermediate values for gradients from 1 to 44 percent. Predicted tons per mile were then applied to the various segment lengths at each of the observed gradients and accumulated to estimate the tons of sediment produced by each segment of Road. Tons of sediment was broken down by the distance to the stream to show the relative amount in each distance interval, even though the buffer distance was assumed to be a constant 30 feet over the road segment being estimated. The result is a conservative estimate of sediment delivered to the stream in question with an implicit margin of safety.

Stream Bank Erosion Inventory Worksheet

Stream Bohannon Creek
Section East Fork section beginning 1/8 mile above confluence of Bohannon
Field Crew Pam Druliner BLM
Jim Fitzgerald EPA
Land Use Irrigated Agriculture/Range

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	45	9.21
	W	113	42.19
Downstream	N	45	8.725
	W	113	42.95

Stream Bank Erosion Calculations

AVE. Bank Height:	2.7	feet
Inventoried Eroding Seg. Length	3600	feet
Percent eroding bank	0.50	
Bank erosion over sampled reach (E)	37	tons/mile/sample reach
Erosion Rate (E_R)	27	tons/mile/year
Miles of Similar Stream Types	1.7	miles
Eroding bank extrapolation	1.7	
Total stream bank erosion	47	tons/year

Inv. bank to bank length (L_{BB}) 7200 feet

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	16	tons/mile/sample reach
Erosion Rate (E_R)	12	tons/mile/year
Miles of Similar Stream Types	1.7	miles
Eroding bank extrapolation	1.7	
Total stream bank erosion	20	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?:
Other Notes:

152

Stream Bank Erosion Inventory Worksheet

Stream Bohannon Creek
Section Upper main fork from ranch houses to confluence with East Fork of Bohannon Creek
Field Crew Scott Feldhausen BLM
Vince Guyer BLM
Land Use Grazing/ Irrigated Agriculture

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	45	9.733
	W	113	42.545
Downstream	N	45	9.12
	W	113	42.275

Stream Bank Erosion Calculations

AVE. Bank Height:	2.0	feet
Inventoried Eroding Seg. Length	3168	feet
Percent eroding bank	0.40	
Bank erosion over sampled reach (E)	167	tons/mile/sample reach
Erosion Rate (E_R)	112	tons/mile/year
Miles of Similar Stream Types	3.2	miles
Eroding bank extrapolation	2.6	
Total stream bank erosion	290	tons/year

Inv. bank to bank length (LBB) 7840 feet

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	8	tons/mile/sample reach
Erosion Rate (E_R)	6	tons/mile/year
Miles of Similar Stream Types	3.2	miles
Eroding bank extrapolation	2.6	
Total stream bank erosion	15	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?: No

Other Notes: Very saturated and wet soils surrounding the stream channel

Stream Bank Erosion Inventory Worksheet

Stream Bohannon Creek
Section Middle Reach From confluence of East Fork Downstream
Field Crew Scott Feldhausen BLM
Vince Guyer BLM
Land Use Grazing

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	45	9.175
	W	113	42.1
Downstream	N	45	8.8
	W	113	42.55

Stream Bank Erosion Calculations

AVE. Bank Height:	5.8	feet
Inventoried Eroding Seg. Length	2474	feet
Percent eroding bank	0.50	
Bank erosion over sampled reach (E)	88	tons/mile/sample reach
Erosion Rate (ER)	94	tons/mile/year
Miles of Similar Stream Types	0.97	miles
Eroding bank extrapolation	0.97	
Total stream bank erosion	91	tons/year

Inv. bank to bank length (LBB) 4948 feet

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	17	tons/mile/sample reach
Erosion Rate (ER)	18	tons/mile/year
Miles of Similar Stream Types	0.97	miles
Eroding bank extrapolation	0.97	
Total stream bank erosion	18	tons/year

Comments

Flow a contributing factor?: Yes, Flashy spring runoff and storm events.

Other contributing factors?: assume sandy gravel for bank material

Other Notes:

154

Stream Bank Erosion Inventory Worksheet

Stream Bohannon Creek
Section Lower Bohannon Creek
Field Crew Pam Druliner BLM
Jim Fitzgerald EPA
Land Use Grazing

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	45	8.55
	W	113	42.75
Downstream	N	45	7.8
	W	113	43.5

Stream Bank Erosion Calculations

AVE. Bank Height:	5.3	feet	Inv. bank to bank length (LBB)	12338	feet
Inventoried Eroding Seg. Length	3497	feet			
Percent eroding bank	0.28				
Bank erosion over sampled reach (E)	210	tons/mile/sample reach			
Erosion Rate (ER)	90	tons/mile/year			
Miles of Similar Stream Types	3.1	miles			
Eroding bank extrapolation	1.8				
Total stream bank erosion	158	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	25	tons/mile/sample reach
Erosion Rate (ER)	10	tons/mile/year
Miles of Similar Stream Types	3.10	miles
Eroding bank extrapolation	1.8	
Total stream bank erosion	18	tons/year

Comments

Flow a contributing factor?: Yes, High flow affecting banks.

Other contributing factors?:

Other Notes:

155

Stream Bank Erosion Inventory Worksheet

Stream	Eighteen Mile Creek
Section	Upper Section above corral
Field Crew	Tom Herron; DEQ Sr. Water Quality Analyst
	Alan Bradbury; Model Watershed Project-Project Planner
Land Use	Grazing

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	44	30.311
	W	113	10.299
Downstream	N	44	30.2
	W	113	11.568

Stream Bank Erosion Calculations

AVE. Bank Height:	2.3	feet
Inventoried Eroding Seg. Length	822	feet
Percent eroding bank	0.06	
Bank erosion over sampled reach (E)	13	tons/mile/sample reach
Erosion Rate (ER)	5	tons/mile/year
Miles of Similar Stream Types	23	miles
Eroding bank extrapolation	3	
Total stream bank erosion	14	tons/year

Inv. bank to bank length (LBB) 13756

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	3	tons/mile/sample reach
Erosion Rate (ER)	1	tons/mile/year
Miles of Similar Stream Types	23.4	miles
Eroding bank extrapolation	2.8	
Total stream bank erosion	3	tons/year

Comments

Flow a contributing factor?: Yes, Seasonal fluctuation results in channel migration on lower half of section

Other contributing factors?: Appears heavily grazed with some side gullies forming from upland run-off.
Willow recolonization is limited by browsing cattle.

Stream Bank Erosion Inventory Worksheet

Stream Eighteen Mile Creek
Section Lower Section below confluence with Divide Creek from upper State land downstream
Field Crew Chris Mebane DEQ
Jim Fitzgerald EPA
Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA
Land Use Grazing/Irrigated Agriculture

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	44	32.487
	W	113	12.82
Downstream	N	44	32.465
	W	113	14.473

Stream Bank Erosion Calculations

AVE. Bank Height:	2.0	feet
Inv. bank to bank length (Lbb)	17146	feet
Inventoried Eroding Seg. Length	2836	feet
Percent eroding bank	0.17	
Bank erosion over sampled reach (E)	16	tons/mile/sample reach
Erosion Rate (Er)	5	tons/mile/year
Miles of Similar Stream Types	28	miles
Eroding bank extrapolation	9	
Total stream bank erosion	47	tons/year

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	4	tons/mile/sample reach
Erosion Rate (Er)	1	tons/mile/year
Miles of Similar Stream Types	28.1	miles
Eroding bank extrapolation	9.3	
Total stream bank erosion	11	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?: Breached irrigation diversion above this pt. contributing sediment

Other Notes: Heavily grazed

157

Stream Bank Erosion Inventory Worksheet

Stream Geertson Creek
Section Upper Reach
Field Crew Pam Druliner BLM
Jim Fitzgerald EPA
Land Use Irrigated Agriculture/Pasture/Range

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	45	11.53
	W	113	43.84
Downstream	N	45	9.93
	W	113	14.42

Stream Bank Erosion Calculations

AVE. Bank Height:	7.7	feet	Inv. bank to bank length (LBB)	8558	feet
Inventoried Eroding Seg. Length	2100	feet			
Percent eroding bank	0.25				
Bank erosion over sampled reach (E)	489	tons/mile/sample reach			
Erosion Rate (ER)	302	tons/mile/year			
Miles of Similar Stream Types	3	miles			
Eroding bank extrapolation	1				
Total stream bank erosion	385	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	26	tons/mile/sample reach
Erosion Rate (ER)	16	tons/mile/year
Miles of Similar Stream Types	2.6	miles
Eroding bank extrapolation	1.3	
Total stream bank erosion	20	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?: Historic Placer Mining

Other Notes:

158

Stream Bank Erosion Inventory Worksheet

Stream Geertson Creek
Section Middle Section below feed lot
Field Crew Pam Druliner BLM
Jim Fitzgerald EPA
Land Use Irrigated Agriculture/Grazing/CAFO

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N		
	W		
Downstream	N		
	W		

Stream Bank Erosion Calculations

AVE. Bank Height:	2.5	feet
Inventoried Eroding Seg. Length	2000	feet
Percent eroding bank	0.26	
Bank erosion over sampled reach (E)	2	tons/mile/sample reach
Erosion Rate (E_R)	1	tons/mile/year
Miles of Similar Stream Types	2.0	miles
Eroding bank extrapolation	1	
Total stream bank erosion	1	tons/year

Inv. bank to bank length (L_{BB}) 7761 feet

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	6	tons/mile/sample reach
Erosion Rate (E_R)	4	tons/mile/year
Miles of Similar Stream Types	2.0	miles
Eroding bank extrapolation	1.0	
Total stream bank erosion	4	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?: Animal access during winter: CAFO

Other Notes: Banks are in good condition however a lot of sediment deposition from animal access and upstream sources.

159

Stream Bank Erosion Inventory Worksheet

Stream Geertson Creek
Section Lower Reach: EnEarl/Bolton property line down to lower Bolton property line
Field Crew Scott Feldhausen BLM
Vince Guyer BLM
Land Use Irrigated Agriculture/Grazing

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	45	8.9
	W	113	44.49
Downstream	N	45	8.94
	W	113	45.08

Stream Bank Erosion Calculations

AVE. Bank Height:	2.4	feet
Inventoried Eroding Seg. Length	4530	feet
Percent eroding bank	0.57	
Bank erosion over sampled reach (E)	45	tons/mile/sample reach
Erosion Rate (ER)	30	tons/mile/year
Miles of Similar Stream Types	3.4	miles
Eroding bank extrapolation	4	
Total stream bank erosion	116	tons/year

Inv. bank to bank length (LBB) 7960 feet

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	14	tons/mile/sample reach
Erosion Rate (ER)	9	tons/mile/year
Miles of Similar Stream Types	3.4	miles
Eroding bank extrapolation	3.9	
Total stream bank erosion	36	tons/year

Comments

Flow a contributing factor?: Yes, diversions above and on this reach decrease flushing capacity.

Other contributing factors?: Limited animal access

Other Notes:

160

Stream Bank Erosion Inventory Worksheet

Stream Kirtley Creek

Section Upper: from fenceline above Bennett residence upstream into placer mining approx. 2,239 ft. **Original inventory reach split into upper and lower segments**

Field Crew Chris Mebane DEQ / Jim Fitzgerald EPA — **Data reduced by** Tom Herron, DEQ / Jim Fitzgerald, EPA

Land Use Placer Mining

Stream Segment Location

		Degrees	Minutes	
GPS: Upstream	N	45	11.206	These are bounds for Upper and Lower Reaches combined
	W	113	47.912	
Downstream	N	45	10.995	
	W	113	48.315	

Stream Bank Erosion Calculations

AVE. Bank Height:	3.9	feet	bank to bank length (LBB)	3680	feet
rled Eroding Seg. Length	2261	feet			
Percent eroding bank	0.61				
n over sampled reach (E)	187	tons/mile/sample reach			
Erosion Rate (ER)	268	tons/mile/year			
f Similar Stream Gradient	4.0	miles			
oding bank extrapolation	5.0				
otal stream bank erosion	1331	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	9	tons/mile/sample reach
Erosion Rate (ER)	13	tons/mile/year
Miles of Similar Stream Types	4.0	miles
Eroding bank extrapolation	5.0	
Total stream bank erosion	67	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?: This reach is currently being placer mined for approximately 2 miles above

Other Notes: Below this reach primary use is grazing and irrigated agriculture

161

Stream Bank Erosion Inventory Worksheet

Stream Kirtley Creek
Section Lower: from Bennett residence upstream into placer mining approx. 2,289 ft.
Field Crew Chris Mebane DEQ
Jim Fitzgerald EPA
Land Use Placer Mining

Original Inventory reach split into upper and lower segments
Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes	
GPS: Upstream	N	45	11.206	These are bounds for Upper and Lower Reaches combined
	W	113	47.912	
Downstream	N	45	10.995	
	W	113	48.315	

Stream Bank Erosion Calculations

AVE. Bank Height:	5.0	feet
Inventoried Eroding Seg. Length	853	feet
Percent eroding bank	0.21	
Bank erosion over sampled reach (E)	97	tons/mile/sample reach
Erosion Rate (ER)	125	tons/mile/year
Miles of Similar Stream Gradient	3.2	miles
Eroding bank extrapolation	1.3	
Total stream bank erosion	166	tons/year

Inv. bank to bank length (LBB) 4100 feet

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	5	tons/mile/sample reach
Erosion Rate (ER)	6	tons/mile/year
Miles of Similar Stream Types	3.2	miles
Eroding bank extrapolation	1.3	
Total stream bank erosion	8	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?: This reach is currently being placer mined for approximately 2 miles above
Other Notes: Below this reach primary use is grazing and irrigated agriculture

162

Stream Bank Erosion Inventory Worksheet

Stream Sandy Creek (upper)
Section Upper Section From private boundary to 0.6 miles downstream
Field Crew Pam Druliner BLM — Data reduced by Tom Herron, DEQ
Jim Fitzgerald EPA — Jim Fitzgerald, EPA
Land Use Range

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	45	3.98
	W	113	38.5
Downstream	N	45	3.08
	W	113	40.01

Stream Bank Erosion Calculations

AVE. Bank Height:	2.0	feet
Inv. bank to bank length (LBB)	6336	feet
Inventoried Eroding Seg. Length	3168	feet
Percent eroding bank	0.50	
Bank erosion over sampled reach (E)	1	tons/mile/sample reach
Erosion Rate (ER)	1	tons/mile/year
Miles of Similar Stream Types	2.2	miles
Eroding bank extrapolation	2.2	
Total stream bank erosion	2	tons/year

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	1	tons/mile/sample reach
Erosion Rate (ER)	1	tons/mile/year
Miles of Similar Stream Types	2.2	miles
Eroding bank extrapolation	2.2	
Total stream bank erosion	2	tons/year

Flow a contributing factor?: No

Other contributing factors?: No

Other Notes: Very saturated and wet soils surrounding the stream channel

Stream Bank Erosion Inventory Worksheet

Stream: Sandy Creek (lower)
Section: Lower Section on Craig Stahl's property
Field Crew: Scott Feldhausen BLM
Vince Guyer BLM
Land Use: Grazing/irrigated agriculture

Data reduced by: Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	45	3.98
	W	113	38.5
Downstream	N	45	3.08
	W	113	40.01

Stream Bank Erosion Calculations

AVE. Bank Height:	0.9	feet
Inventoried Eroding Seg. Length	3825	feet
Percent eroding bank	0.50	
Bank erosion over sampled reach (E)	6	tons/mile/sample reach
Erosion Rate (Er)	4	tons/mile/year
Miles of Similar Stream Types	1	miles
Eroding bank extrapolation	1	
Total stream bank erosion	3	tons/year

Inv. bank to bank length (Lbb) 7650 feet

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	3	tons/mile/sample reach
Erosion Rate (Er)	2	tons/mile/year
Miles of Similar Stream Types	0.9	miles
Eroding bank extrapolation	0.9	
Total stream bank erosion	2	tons/year

Comments

Flow a contributing factor?: No.

Other contributing factors?: No.
Other Notes: Very good ecological health

164

Stream Bank Erosion Inventory Worksheet

Stream McDevitt Creek
Section Upper; above private land
Field Crew Tom Herron; Sr. Water Quality Analyst
Elton Modroo; Geologist
Land Use Transportation Corridor

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	44	57.44
	W	113	47.55
Downstream	N	44	55.749
	W	113	45.695

Stream Bank Erosion Calculations

AVE. Bank Height:	7.9	feet
Inventoried Eroding Seg. Length	10560	feet
Percent eroding bank	0.36	
Bank erosion over sampled reach (E)	131	tons/mile/sample reach
Erosion Rate (E_R)	24	tons/mile/year
Miles of Similar Stream Types	5	miles
Eroding bank extrapolation	3	
Total stream bank erosion	80	tons/year

Inv. bank to bank length (L_{BB}) 29062 feet

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	113	tons/mile/sample reach
Erosion Rate (E_R)	21	tons/mile/year
Miles of Similar Stream Types	5	miles
Eroding bank extrapolation	3.36	
Total stream bank erosion	69	tons/year

Comments

Flow a contributing factor?: Runoff impulse is greater than stream channel available because of the road, resulting in erosion.
Other contributing factors?: Narrow canyon with scree slides and road bounding creek
Other Notes: Low fall flow apparent resulting in little fisheries value, road leaves stream on upper end of reach.

165

Stream Bank Erosion Inventory Worksheet

Stream McDevitt Creek
Section Middle section from lower cattle crossing to lower private boundary
Field Crew Tom Herron DEQ; Sr. Water Quality Analyst
Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Land Use Grazing, transportation corridor

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	44	55.749
	W	113	45.695
Downstream	N	44	55.532
	W	113	42.682

Stream Bank Erosion Calculations

AVE. Bank Height:	2.6	feet
Inventoried Eroding Seg. Length	3380	feet
Percent eroding bank	0.12	
Bank erosion over sampled reach (E)	291	tons/mile/sample reach
Erosion Rate (ER)	53	tons/mile/year
Miles of Similar Stream Types	3.48	miles
Eroding bank extrapolation	0.81	
Total stream bank erosion	43	tons/year

Inv. bank to bank length (LBB) 29062 feet

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	16	tons/mile/sample reach
Erosion Rate (ER)	3	tons/mile/year
Miles of Similar Stream Types	3.48	miles
Eroding bank extrapolation	0.81	
Total stream bank erosion	2.4	tons/year

Comments

Flow a contributing factor?: Yes, channel is constrained by road and steep canyon walls resulting in decreased energy dissipation.
Other contributing factors?: Upper portion heavily grazed, lower section less so. Dipping Vat Rd gully.
Other Notes: Flow from Sawmill Canyon appears important because flow appears to decrease significanly above this pt. Also above this pt is timbered, N.facing slope,S aspect much scree.

166

Stream Bank Erosion Inventory Worksheet

Stream McDevitt Creek
Section Lower Section at Canyon Mouth
Field Crew Tom Herron DEQ; Sr Water Quality Analyst
Data reduced by Tom Herron, DEQ; Jim Fitzgerald, EPA
Land Use Grazing/Transportation Corridor

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	44	55.532
	W	113	42.602
Downstream	N	44	55.901
	W	113	40.00

Stream Bank Erosion Calculations

AVE. Bank Height:	2.5	feet
Inventoried Eroding Seg. Length	405	feet
Percent eroding bank	0.03	
Bank erosion over sampled reach (E)	3	tons/mile/sample reach
Erosion Rate (Er)	1	tons/mile/year
Miles of Similar Stream Types	1	miles
Eroding bank extrapolation	0.06	
Total stream bank erosion	0.06	tons/year

Inv. bank to bank length (Lee) 15984 feet

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	1	tons/mile/sample reach
Erosion Rate (Er)	0.5	tons/mile/year
Miles of Similar Stream Types	1	miles
Eroding bank extrapolation	0.06	
Total stream bank erosion	0.03	tons/year

Comments

Flow a contributing factor?: Yes, because the stream is constrained by the road, erosion is intensified due to decreased energy dissipation by meandering.

Other contributing factors?:

Other Notes: Steep erosive canyon with rills and side gullies present but all appear stable except deep gully adjacent to Dipping Vat rd, where alluvial fan extends to McDevitt Cr.

167

Stream Bank Erosion Inventory Worksheet

Stream McDevitt Creek — GULLY

Section Dipping Vat Road gully

Field Crew Tom Herron:Sr. Water Quality Analyst
Elton Modroo: Geologist

Land Use Grazing/Transportation Corridor

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

Inv. bank to bank length (Lbb) 12672 feet

			Degrees	Minutes
GPS: Upstream		N	44	54.5
		W	113	43.7
	Downstream	N	44	55.25
		W	113	50.5

Gully Erosion Calculations

Total weight eroded	3267.0	tons	
Time since failure	6	years	since 1992
Average annual erosion rate	545	tons per year	

Comments

Flow a contributing factor?: Impulse flow from storm events and spring runoff drives the gully erosion here accentuated by road design and erosive soil.

Other contributing factors?: Narrow, steep valley with heavily grazed slopes and reduced vegetation.

Other Notes: Road erosion is evident with cultural features recently placed eroding into gully

168

Stream Bank Erosion Inventory Worksheet

Stream Wimpey Creek

Section Upper Section: Mouth of Canyon on Jim Riggan property to mid section of his property

Field Crew Tom Herron DEQ
Elton Modroo DEQ

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Land Use Grazing

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	45	7.938
	W	113	40.858
Downstream	N	45	7.522
	W	113	41.041

Stream Bank Erosion Calculations

AVE. Bank Height:	8.3	feet
Inventoried Eroding Seg. Length	165	feet
Percent eroding bank	0.04	
Bank erosion over sampled reach (E)	4	tons/mile/sample reach
Erosion Rate (E_R)	5	tons/mile/year
Miles of Similar Stream Types	0.56	miles
Eroding bank extrapolation	0.04	
Total stream bank erosion	0.21	tons/year

Inv. bank to bank length (L_{BB}) 4456 feet

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	2	tons/mile/sample reach
Erosion Rate (E_R)	2	tons/mile/year
Miles of Similar Stream Types	0.56	miles
Eroding bank extrapolation	0.04	
Total stream bank erosion	0.09	tons/year

Comments

Flow a contributing factor?: Steep narrow canyon above this site to source likely results in very flashy runoff as evidenced by large (0.5') cobble substrate. Above this pt there is little deposition.

Other contributing factors?: Grazing is extensive, also heavy big game winter range use through out this reach

Other Notes: Reduced bank stability is exacerbated by flashy spring runoff with much recession resulting from spring 1997's heavy runoff. Landowner states heaviest he's seen in 25 years on property.

169

Stream Bank Erosion Inventory Worksheet

Stream Wimpey Creek
Section Middle Section Lower reach of Riggan property
Field Crew Tom Herron DEQ
Elton Modroo DEQ
Land Use Grazing/Irrigated Pasture

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N	45	7.522
	W	113	41.041
Downstream	N	45	6.997
	W	113	41.571

4826 0.914015
9652

Stream Bank Erosion Calculations

AVE. Bank Height:	5.8	feet
Inventoried Eroding Seg. Length	720	feet
Percent eroding bank	0.09	
Bank erosion over sampled reach (E)	96	tons/mile/sample reach
Erosion Rate (ER)	60	tons/mile/year
Miles of Similar Stream Types	0.91	miles
Eroding bank extrapolation	0.16	
Total stream bank erosion	9.3	tons/year

Inv. bank to bank length (LBB) 8428 feet

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	6	tons/mile/sample reach
Erosion Rate (ER)	4	tons/mile/year
Miles of Similar Stream Types	0.91	miles
Eroding bank extrapolation	0.16	
Total stream bank erosion	0.61	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?: excessive irrigation of pasture is causing large side gullies over 11% grade to creek

Other Notes: less than 2" stubble height remaining on pasture.

170

Stream Bank Erosion Inventory Worksheet

Stream Wimpey Creek

Section Middle-lower section through canyon

Field Crew extrapolated from upper reach

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Land Use Grazing/Irrigated Pasture

Stream Segment Location

		Degrees	Minutes		
GPS: Upstream	N				
	W			6617	1.253219697
Downstream	N				
	W				

Stream Bank Erosion Calculations

AVE. Bank Height:		feet	Inv. bank to bank length (LBB)		feet
Inventoried Eroding Seg. Length		feet			
Percent eroding bank	0.04				
Bank erosion over sampled reach (E)		tons/mile/sample reach			
Erosion Rate (ER)	5	tons/mile/year			
Miles of Similar Stream Types	1	miles			
Eroding bank extrapolation	0.10				
Total stream bank erosion	1	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	0	tons/mile/sampl
Erosion Rate (ER)	2	tons/mile/year
Miles of Similar Stream Types	1	miles
Eroding bank extrapolation	0.10	
Total stream bank erosion	0.2	tons/year

Comments

Flow a contributing factor?:

Other contributing factors?:

Other Notes:

171

Stream Bank Erosion Inventory Worksheet

Stream Wimpey Creek
Section Lower Reach
Field Crew extrapolated from Middle Reach
BURP scores show high unstable banks
Land Use Grazing/Irrigated Pasture

Data reduced by Tom Herron, DEQ
Jim Fitzgerald, EPA

Stream Segment Location

		Degrees	Minutes
GPS: Upstream	N		
	W		
Downstream	N		
	W		

Stream Bank Erosion Calculations

AVE. Bank Height:		feet	Inv. bank to bank length (LBB)		feet
Inventoried Eroding Seg. Length		feet			
Percent eroding bank	0.09				
Bank erosion over sampled reach (E)	0	tons/mile/sample reach			
Erosion Rate (ER)	60	tons/mile/year			
Miles of Similar Stream Types	0.83	miles			
Eroding bank extrapolation	0.15				
Total stream bank erosion	[redacted]	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	0	tons/mile/sampl
Erosion Rate (ER)	4	tons/mile/year
Miles of Similar Stream Types	1	miles
Eroding bank extrapolation	0.15	
Total stream bank erosion	[redacted]	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?:

Other Notes:

Feature Type	Number of features	Percent of total
Shallow Rotational Slide (SRS)	5	9
Debris Slide (DS)	34	59
Gully (GL)	19	33
Total	58	

Triggering Mechanism		percent
Management	37	64
Natural	21	36
Total	58	

drainage area (square miles)	Mass Wasting frequency	Management related frequency	Natural Mass Wasting frequency
21.6	3	2	1

Feature ID	Feature Type	Management	Natural
46-L1	DS	x	
46-L2	DS	x	
46-L3	DS	x	
46-L4	DS	x	
46-L5	DS	x	
46-L6	DS	x	
46-L7	DS	x	
46-L8	DS	x	
46-n1	GL		x
46-n2	GL		x
46-n3	GL		x
46-n4	GL		x
46-n5	GL		x
60-2	GL	x	
60-3	GL	x	
60-4	GL	x	
60-5	GL	x	
60-6	GL	x	
60-7	GL	x	
60-L1	SRS	x	
60-L2	SRS	x	
60-L3	DS	x	
60-L4	DS	x	
60-L5	DS		X
74-L1	DS		X
74-L2	DS		X
74-L3	DS	X	
74-L4	DS	X	
74-L5	DS		X
74-L6	DS		X
74-L7	DS		X
74-L8	DS		X
74-L9	SRS	X	
74-L10	DS		X
74-L11	DS		X
74-L12	DS		X
74-L13	DS	X	
74-L14	SRS	X	
74-N1	GL		X
74-N2	GL		X
93-L1	DS		X
93-L2	DS		X
93-L3	SRS	X	
93-L4	DS	X	
93-L5	DS		X
93-L6	DS	X	
98-L1	DS		X
98-L2	DS	X	
98-L3	DS	X	
98-L4	DS	X	
98-L5	DS	X	
98-L6	DS	X	
98-1	GL	X	
98-2	GL	X	
98-3	GL	X	
98-4	GL	X	
98-5	GL	X	
98-6	GL	X	

173

Gully Survey for Wimpey Creek Watershed

Site G-4 — GPS File: R082015A R082015B

Date 08/19/98 — Dominate Slope 11 degress

Crew Herron and Fitzgerald — Azimuth 335 degress

Volume Estimate for deposit

Road Segment	Road Slope (degrees)	BSH(ft)	Width (ft)	Area (ft2)	Length (ft)	Approximate Volume (ft3)	Bulk Density (pcf)	Wieght (tons)
1	5	0.5	0.5	0.25	240	60	90	3
2	6	0.2	0.8					
		0.5	1.3					
		0.8	1.3					
		0.6	2.3					
		0.9	2.3					
	Average	0.6	1.6	0.96	165	158.4	90	7
3	5	0.7	1.3					
		0.7	1.8					
		0.9	2.3					
		0.8	1.9					
	Average	0.775	1.825	1.41	165	233.4	90	11
4	6	0.7	1.3					
		0.9	2.3					
		1.3	2.5					
		1.5	1.8					
	Average	1.1	1.975	2.17	129	280.3	90	13
5	10	2	3.8					
		3.5	4.7					
		2.8	3.5					
		2.6	2.6					
		1.1	2.4					
	Average	2.4	3.4	8.16	102	832.3	90	37
							Cumulative Erosion (tons)	70
							Time of formation	1996
							Delivery Ratio	0.25
							Total Delivered	18
							Average (t/y)	9

174

Mass Failure Survey for Wimpey Creek Watershed

Site GPS File:
Date 08/19/98 Dominant Slope: degrees
Crew Herron and Fitzgerald Azimuth: degrees

Volume Estimate for deposit

Landslide Facet	BSH(ft)	Width (ft)	Area (ft2)	Length (ft)	Approximate Volume (ft3)	Bulk Density (pcf)	Weight (tons)	Total displaced weight	Delivered weight (tons)	Percent delivered
Crown	20	300	6000	300	1800000	90	81000	118969	65813	55
Mid Chnnl	15	150	2250	375	843750	90	37969			
Deposit	6	525	3150	375	1181250	90	53156			